Amendments to the Claims:

The listing of claims will replace all prior versions, and listings, of claims in the application:

Listing of Claims:

1. (Currently Amended) An optical apparatus comprising:

a microscope optical system having:

a light source,

an illumination optical system ~~for leading~~ that leads light emitted from ~~said~~ the light source to an object to be observed,

an imaging optical system ~~for forming~~ that forms an image of ~~said~~ the object, and

at least one polarizing member ~~for separating~~ that separates the light from ~~said~~ the light source into two polarized components;

an adjusting member ~~for changing~~ that changes an amount of retardation between ~~said~~ the two polarized components; ~~and~~

an image pick-up member ~~for photographing~~ that picks up a differential interference contrast image of ~~said~~ the object; and

a computer,

wherein the computer performs a difference operation and a sum operation for each pair of corresponding pixels in pictures of two differential interference contrast images of the object that are picked up by the image pick-up member and that have retardations

equal in amount and different in sign, to obtain difference image information and sum image information, and detects an amount of phase $\Phi(x,y)$ on a surface of the object corresponding to image information for each pixel by using one of the following equations:

~~operated through a process for photographing two differential interference contrast images relative to said object in which amounts of retardation are equal, but have different signs,~~

~~wherein a processing unit is provided and is operated through a calculation process for performing a differential calculation and a summed calculation relative to respective pixels corresponding to said two differential interference contrast images to obtain differential image information and summed image information and a calculation process for detecting an amount of phase on a surface of said object by using one of the following equations:~~

$$\Phi(x,y) = k \cdot \{(1-\cos\theta) \cdot d(x,y) / \alpha\} / \{\sin\theta \cdot [1-\{d(x,y) / \alpha\}^2 / 2]\}$$

$$\Phi(x,y) = k \cdot \tan^{-1}[\{(1-\cos\theta) \cdot d(x,y) / \alpha\} / \{\sin\theta \cdot [1-\{d(x,y) / \alpha\}^2 / 2]\}]$$

where θ is the amount of retardation~~;~~, $D(x,y)$ is the difference image information, $S(x,y)$ is the sum image information, $\Phi(x,y)$ is ~~said~~ the amount of phase on the surface of ~~said~~ the object corresponding to ~~said differential~~ image information ~~and said summed image information; when said differential image information is represented by $D(x,y)$~~ for each pixel, $d(x,y)$ is image information ~~in which said differential~~ that is yielded by deconvolution of the

difference image information $D(x,y)$ ~~is deconvoluted by~~ using an optical transfer function of ~~said~~ the microscope optical system~~; when said summed image information is represented by $S(x,y)$~~, α is an average value of ~~said summed~~ the sum image information $S(x,y)$~~;and~~, $k = \lambda/4\pi$, ~~where~~ and λ is a wavelength.

2. (Currently Amended) An optical apparatus comprising:

an interference optical system having:

a light source,

an illumination optical path ~~for leading~~ that leads light emitted from ~~said~~ the light source to an object to be observed, and

a reference optical path ~~for leading~~ that leads the light from ~~said~~ the light source to a reference surface; ~~and~~

an image pick-up member ~~for photographing~~ that picks up an interference image of ~~said~~ the object formed by ~~said~~ the interference optical system; and

a computer,

wherein ~~a processing unit is provided and is operated through a calculation process for detecting~~ the computer detects an amount of phase $\Phi(x,y)$ on a surface of ~~said~~ the object by using one of the following equations:

$$\Phi(x,y) = k \cdot \{h(x,y) / J_m(x,y)\}$$

$$/\{[1- \{h(x,y) / Jm(x,y)\}^2 / 2]\}$$

$$\Phi(x,y) = k \cdot \tan^{-1}[k \cdot \{h(x,y) / Jm(x,y)\}$$

$$/ \{[1-\{h\,(x,y) / Jm\,(x,y)\}^2 / 2]\}]$$

where ~~when~~ $H(x,y)$ is image information ~~in which~~ that is a phase distribution ~~of~~ ~~said~~ the object ~~is~~ as picturized ~~is represented by $H(x,y)$~~, $h(x,y)$ is image information ~~in which said~~ that is yielded by deconvolution of the image information $H(x,y)$ ~~is deconvoluted by~~ using an optical transfer function of ~~said~~ the interference optical system~~; when~~, $J(x,y)$ is image information ~~in which~~ that is an intensity distribution ~~is~~ as picturized ~~is represented by $J(x,y)$~~, $J_m(x,y)$ is image information in which maxima of ~~said~~ the image information $J(x,y)$ are enveloped~~;~~, $\Phi(x,y)$ is ~~said~~ the amount of phase on the surface of ~~said~~ the object~~; and~~, $k = \lambda/4\pi$, ~~where~~ and λ is a wavelength.

3. (Currently Amended) An optical apparatus comprising:

a microscope optical system having:

a light source,

an illumination optical system ~~for leading~~ that leads light emitted from ~~said~~ the light source to an object to be observed,

an imaging optical system ~~for forming~~ that forms an image of ~~said~~ the object, and

at least one polarizing member ~~for separating~~ that separates the light from ~~said~~ the light source into two polarized components;

an adjusting member ~~for changing~~ that changes an amount of retardation between ~~said~~ the two polarized components; ~~and~~

an image pick-up member ~~for photographing~~ that picks up a differential interference contrast image of ~~said~~ the object; and

a computer,

wherein the computer performs a difference operation and a sum operation for each pair of corresponding pixels in pictures of two differential interference contrast images of the object that are picked up by the image pick-up member and that have retardations equal in amount and different in sign, to obtain difference image information and sum image information, and detects an amount of phase $\Phi(x,y)$ on a surface of the object by using one of the following equations:

~~operated through a process for photographing two differential interference contrast images relative to said object in which amounts of retardation are equal, but have different signs,~~

~~wherein a processing unit is provided and is operated through a calculation process for performing a differential calculation and a summed calculation relative to respective pixels corresponding to said two differential interference contrast images to obtain differential image information and summed image information and a calculation process for detecting an amount of phase on a surface of said object by using one of the following equations:~~

$$\Phi(x,y) = k \cdot \{(1-\cos\theta) \cdot d(x,y) / \beta(x,y)\} / \{\sin\theta \cdot [1 - \{d(x,y)/\beta(x,y)\}^2 / 2]\}$$

$$\Phi(x,y) = k \cdot \tan^{-1}[\{(1-\cos\theta) \cdot d(x,y) / \beta(x,y)\} / \{\sin\theta \cdot [1-\{d(x,y)/\beta(x,y)\}^2/2]\}]$$

where θ is the amount of retardation~~;~~ between the two polarized components, $D(x,y)$ is the difference image information, $S(x,y)$ is the sum image information, $\Phi(x,y)$ is ~~said~~ the

amount of phase on the surface of ~~said~~ the object corresponding to ~~said differential~~ image information ~~and said summed image information; when said differential image information is represented by $D(x,y)$~~ for each pixel, $d(x,y)$ is image information ~~in which said differential~~ that is yielded by deconvolution of the difference image information $D(x,y)$ ~~is deconvoluted by~~ using an optical transfer function of ~~said~~ the microscope optical system~~; when said summed image information is represented by $S(x,y)$~~, $\beta(x,y)$ is image information ~~enveloping~~ in which maxima of ~~said summed~~ the sum image information $S(x,y)$~~; and~~ are enveloped, $k = \lambda/4\pi$, ~~where~~ and λ is a wavelength.

4. (Currently Amended) An optical apparatus comprising:

a microscope optical system having:

a light source,

an illumination optical system ~~for leading~~ that leads light emitted from ~~said~~ the light source to an object to be observed,

an imaging optical system ~~for forming~~ that forms an image of ~~said~~ the object, and

at least one polarizing member ~~for separating~~ that separates the light from ~~said~~ the light source into two polarized components;

an adjusting member ~~for changing~~ that changes an amount of retardation between ~~said~~ the two polarized components; ~~and~~

an image pick-up member ~~for photographing~~ that picks up a differential interference contrast image of ~~said~~ the object; and

a computer,

wherein the computer performs a difference operation and a sum operation for each pair of corresponding pixels in pictures of two differential interference contrast images of the object that are picked up by the image pick-up member and that have retardations equal in amount and different in sign, to obtain difference image information and sum image information, and detects an amount of phase $\Phi(x,y)$ on a surface of the object corresponding to image information for each pixel by using one of the following equations:

~~operated through a process for photographing two differential interference contrast images relative to said object in which amounts of retardation are equal, but have different signs,~~

~~wherein a processing unit is provided and is operated through a calculation process for performing a differential calculation and a summed calculation relative to respective pixels corresponding to said two differential interference contrast images to obtain differential image information and summed image information and a calculation process for detecting an amount of phase on a surface of said object by using one of the following equations:~~

$$\Phi(x,y) = k \cdot \{(1-\cos\theta) \cdot d(x,y)\}/\{\sin\theta \cdot \Gamma(x,y)\}$$

$$\Phi(x,y) = k \cdot \tan^{-1}[k \cdot \{(1-\cos\theta) \cdot d(x,y)\} / \{\sin\theta \cdot \Gamma(x,y)\}]$$

Where θ is the amount of retardation~~;~~ between the two polarized components as detected, $D(x,y)$ is the difference image information, $S(x,y)$ is the sum image information, $\Phi(x,y)$ is ~~said~~ the amount of phase on the surface of ~~said~~ the object corresponding to ~~said differential~~ image information ~~and said summed image information; when said differential image information is~~

~~represented by $D(x,y)$~~ for each pixel, $d(x,y)$ is image information ~~in which said differential~~ that is yielded by deconvolution of the difference image information $D(x,y)$ ~~is deconvoluted by~~ using an optical transfer function of ~~said~~ the microscope optical system~~; when said summed image information is represented by $S(x,y)$~~, $\Gamma(x,y)$ is image information ~~in which~~ that is composed of information of a low-frequency component ~~is~~ extracted from ~~said summed~~ the sum image information $S(x,y)$~~; and~~, $k = \lambda/4\pi$, ~~where~~ and λ is a wavelength.

5. (Currently Amended) An optical apparatus comprising:

an interference optical system having:

a light source,

an illumination optical path ~~for leading~~ that leads light emitted from ~~said~~ the light source to an object to be observed, and

a reference optical path ~~for leading~~ that leads the light from ~~said~~ the light source to a reference surface; ~~and~~

an image pick-up member ~~for photographing~~ that picks up an interference image of ~~said~~ the object formed by ~~said~~ the interference optical system; and

a computer,

wherein ~~a processing unit is provided and is operated through a calculation process for detecting~~ the computer detects an amount of phase $\Phi(x,y)$ on a surface of ~~said~~ the object by using one of the following equations:

$$\Phi(x,y) = k \cdot \{h(x,y) / Jc\} / \{[1 - \{h(x,y) / Jc\}^2 / 2]\}$$

$$\Phi(x,y) = k \cdot \tan^{-1}[k \cdot \{h(x,y) / Jc\} / \{[1 - \{h(x,y) / Jc\}^2 / 2]\}]$$

where ~~when~~ $H(x,y)$ is image information ~~in which~~ that is a phase distribution of ~~said~~ the object ~~is~~ as picturized ~~is represented by $H(x,y)$~~ by the interference optical system, $h(x,y)$ is image information ~~in which said~~ that is yielded by deconvolution of the image information $H(x,y)$ ~~is deconvoluted by~~ using an optical transfer function of ~~said~~ the interference optical system~~; when~~ , $J(x,y)$ is image information ~~in which~~ that is an intensity distribution ~~is~~ as picturized ~~is represented by $J(x,y)$~~, J_c is ~~a~~ an average value ~~in which~~ of maxima of ~~said~~ the image information $J(x,y)$ ~~are averaged;~~, $\Phi(x,y)$ is the amount of phase on the surface of ~~said~~ the object~~; and~~, $k = \lambda/4\pi$, ~~where~~ and λ is a wavelength.

6. (Currently Amended) An optical apparatus comprising:

an interference optical system having:

a light source,

an illumination optical path ~~for leading~~ that leads light emitted from ~~said~~ the light source to an object to be ~~observe~~ observed, and

a reference optical path ~~for leading~~ that leads the light from ~~said~~ the light source to a reference surface; ~~and~~

an image pick-up member ~~for photographing~~ that picks up an interference image of ~~said~~ the object formed by ~~said~~ the interference optical system; and

a computer,

wherein ~~a processing unit is provided and is operated through a calculation process for detecting~~ the computer detects an amount of phase $\Phi(x,y)$ on a surface of ~~said~~ the object by using one of the following equations:

$$\Phi(x,y) = k \cdot \{h(x,y) / Ja(x,y)\} / \{[1 - \{h(x,y) / Ja(x,y)\}^2 / 2]\}$$

$$\Phi(x,y) = k \cdot \tan^{-1}[k \cdot \{h(x,y) / Ja(x,y)\} / \{[1 - \{h(x,y) / Ja(x,y)\}^2 / 2]\}]$$

where ~~when~~ $H(x,y)$ is image information ~~in which~~ that is a phase distribution of ~~said~~ the object ~~is~~ as picturized ~~is represented by $H(x,y)$~~ by the interference optical system, $h(x,y)$ is image information ~~in which said~~ that is yielded by deconvolution of the image information $H(x,y)$ ~~is deconvoluted by~~ using an optical transfer function of ~~said~~ the interference optical system~~; when~~ , $J(x,y)$ is image information ~~in which~~ that is an intensity distribution ~~is~~ as picturized ~~is represented by $J(x,y)$~~, $J_a(x,y)$ is ~~a~~ an average value ~~in which said~~ of the image information J(x, y) ~~is divided~~ as calculated for a predetermined region ~~and which is averaged in said region;~~ therein, $\Phi(x,y)$ is the amount of phase on the surface of ~~said~~ the object~~; and~~, $k = \lambda/4\pi$, ~~where~~ and λ is a wavelength.

7. (Currently Amended) An optical apparatus comprising:

an interference optical system having:

a light source,

an illumination optical path ~~for leading~~ that leads light emitted from ~~said~~ the light source to an object to be observe, and

a reference optical path ~~for leading~~ that leads the light from ~~said~~ the light source to a reference surface; ~~and~~

an image pick-up member ~~for photographing~~ that picks up an interference image of ~~said~~ the object formed by ~~said~~ the interference optical system; and

a computer,

wherein ~~a processing unit is provided and is operated through a calculation process for detecting~~ the computer detects an amount of phase on a surface of ~~said~~ the object by using one of the following equations:

$$\Phi(x,y) = k \cdot \{h(x,y) / JL(x,y)\} / \{[1-\{h(x,y) / JL(x,y)\}^2 / 2]\}$$

$$\Phi(x,y) = k \cdot \tan^{-1}[k \cdot \{h(x,y) / JL(x,y)\} / \{[1-\{h(x,y) / JL(x,y)\}^2 / 2]\}]$$

where ~~when~~ $H(x,y)$ is image information ~~in which~~ that is a phase distribution of ~~said~~ the object ~~is~~ as picturized ~~is represented by $H(x,y)$~~ by the interference optical system, $h(x,y)$ is image information ~~in which said~~ that is yielded by deconvolution of the image information $H(x,y)$ ~~is deconvoluted by~~ using an optical transfer function of ~~said~~ the interference optical system~~; when~~, $J(x,y)$ is image information ~~in which~~ that is an intensity distribution ~~is~~ as picturized ~~is represented by $J(x,y)$~~, $J_L(x,y)$ is image information ~~in which~~ that is composed of information of a low-frequency component ~~is~~ extracted from ~~said~~ the image information $J(x,y)$~~;~~, $\Phi(x,y)$ is the amount of phase on the surface of ~~said~~ the object~~; and~~, $k = \lambda/4\pi$, ~~where~~ and λ is a wavelength.

8. (Currently Amended) An optical apparatus comprising:

a microscope optical system having:

a light source,

an illumination optical system ~~for leading~~ that leads light emitted from said light source to an object to be observed,

an imaging optical system ~~for forming~~ that forms an image of ~~said~~ the object, and

at least one polarizing member ~~for separating~~ that separates the light from ~~said~~ the light source into two polarized components;

an adjusting member ~~for changing~~ that changes an amount of retardation between ~~said~~ the two polarized components; ~~and~~

an image pick-up member ~~for photographing~~ that picks up a differential interference contrast image of ~~said~~ the object; and

a computer,

wherein the computer performs a difference operation and a sum operation for each pair of corresponding pixels in pictures of two differential interference contrast images of the object that are picked up by the image pick-up member and that have retardations equal in amount and different in sign, to obtain difference image information and sum image information, and detects a phase distribution $\Phi(x,y)$ on a surface of the object by using the following equation:

~~operated through a process for photographing two differential interference contrast images relative to said object in which amounts of retardation are equal, but have different signs,~~

~~wherein said optical apparatus is operated through a process for performing a differential calculation and a summed calculation relative to respective pixels corresponding to said two differential interference contrast images to obtain differential image information and summed image information and a process for calculating a phase distribution from said differential image information and said summed image information, having a processing unit operated through a calculation process for detecting a phase distribution on said object by using the following equation:~~

$$\Phi(x,y) = \varphi(x,y) / \{1 - [\varphi(x,y)]^2 / 2\}$$

where $\varphi(x,y)$ is a phase distribution that is calculated from ~~said differential~~ the difference image information and ~~said summed~~ the sum image information and $\Phi(x,y)$ is the phase distribution on ~~said~~ the surface of the object.

9. (Currently Amended) An optical apparatus comprising:

a microscope optical system having:

a light source,

an illumination optical system ~~for leading~~ that leads light emitted from ~~said~~ the light source to an object to be observed,

an imaging optical system ~~for forming~~ that forms an image of ~~said~~ the object, and

at least one polarizing member ~~for separating~~ that separates the light from ~~said~~ the light source into two polarized components;

an adjusting member ~~for changing~~ that changes an amount of retardation between ~~said~~ the two polarized components; ~~and~~

an image pick-up member ~~for photographing~~ that picks up a differential interference contrast image of said object; and

a computer,

wherein the computer performs a difference operation and a sum operation for each pair of corresponding pixels in pictures of two differential interference contrast images of the object that are picked up by the image pick-up member and that have retardations equal in amount and different in sign, to obtain difference image information and sum image information, processes the difference image information with a deconvolution operation using an optical transfer function of the imaging optical system, calculates out a phase distribution from the difference image information that has undergone the deconvolution operation and the sum image information, and detects a phase distribution $\Phi(x,y)$ on a surface of the object using the following equation:

~~operated through a process for photographing two differential interference contrast images relative to said object in which amounts of retardation are equal, but have different signs,~~

~~wherein said optical apparatus is operated through a process for performing a differential calculation and a summed calculation relative to respective pixels corresponding to said two differential interference contrast images to obtain differential image information and summed image information, a process for using an optical transfer function of said imaging optical system for deconvolution processing of said differential image information, and a process for calculating a phase distribution from said differential image information obtained by the deconvolution processing and said summed image~~

~~information, having a processing unit operated through a calculation process for detecting a phase distribution on said object by using the following equation:~~

$$\Phi(x,y) = \varphi_d(x,y) / \{1 - [\varphi_d(x,y)]^2 / 2\}$$

where $\varphi_d(x,y)$ is ~~a~~ the phase distribution calculated out from ~~said differential~~ the difference image information ~~obtained by~~ that has undergone the deconvolution ~~processing~~ operation and ~~said summed~~ the sum image information and $\Phi(x,y)$ is ~~a~~ the phase distribution on ~~said~~ the surface of the object.

10. (Currently Amended) An optical apparatus comprising:

a microscope optical system having:

a light source,

an illumination optical system ~~for leading~~ that leads light emitted from ~~said~~ the light source to an object to be observed,

an imaging optical system ~~for forming~~ that forms an image of ~~said~~ the object, and

at least one polarizing member ~~for separating~~ that separates the light from ~~said~~ the light source into two polarized components;

an adjusting member ~~for changing~~ that changes an amount of retardation between ~~said~~ the two polarized components; ~~and~~

an image pick-up member ~~for photographing~~ that picks up a differential interference contrast image of ~~said~~ object; and

a computer,

wherein the computer detects a phase distribution $\Phi(x,y)$ on a surface of the object from at least three differential interference contrast images that are picked up by the image pick-up member and that have different amounts of retardation by using the following equation:

~~operated through a process for photographing at least three differential interference contrast images of different amounts of retardation,~~

~~wherein said optical apparatus is operated through a process for calculating a phase distribution from said at least three differential interference contrast images of different amounts of retardation, having a processing unit operated through a calculation process for detecting a phase distribution on said object by using the following equation:~~

$$\Phi(x,y) = \varphi_f(x,y) / \{1 - [\varphi_f(x,y)]^2 / 2\}$$

where $\varphi_f(x,y)$ is a phase distribution calculated from ~~said~~ the three differential interference contrast images and $\Phi(x,y)$ is ~~a~~ the phase distribution on ~~said~~ the surface of the object.

11. (Currently Amended) An optical apparatus comprising:

a microscope optical system having:

a light source,

an illumination optical system ~~for leading~~ that leads light emitted from ~~said~~ the light source into an object to be observed,

an imaging optical system ~~for forming~~ that forms an image of ~~said~~ the object, and

at least one polarizing member ~~for separating~~ that separates the light from ~~said~~ the light source into two polarized components;

an adjusting member ~~for changing~~ that changes an amount of retardation between ~~said~~ the two polarized components; ~~and~~

an image pick-up member ~~for photographing~~ that picks up a differential interference contrast image of ~~said~~ the object; and

a computer,

wherein the computer calculates out a phase distribution from at least three differential interference contrast images that are picked up by the image pick-up member and that have different amounts of retardation, processes the phase distribution with a deconvolution operation using an optical transfer function of the imaging optical system, and detects a phase distribution $\Phi(x,y)$ on a surface of the object using the following equation:

~~operated through a process for photographing at least three differential interference contrast images of different amounts of retardation,~~

~~wherein said optical apparatus is operated through a process for calculating a phase distribution from said at least three differential interference contrast images of different amounts of retardation and a process for using an optical transfer function of said imaging optical system for deconvolution processing of a calculated phase distribution, having a processing unit operated through a calculation process for detecting a phase distribution on said object by using the following equation:~~

$$\Phi(x,y) = \varphi_{fd}(x,y) / \{1 - [\varphi_{fd}(x,y)]^2 / 2\}$$

where $\varphi_{fd}(x,y)$ is ~~a~~ the phase distribution ~~obtained by~~ that has undergone the deconvolution ~~processing~~ operation and $\Phi(x,y)$ is ~~a~~ the phase distribution on ~~said~~ the object.

12. (Currently Amended) An optical apparatus comprising:

an interference optical system having:

a light source;

an illumination optical path ~~for leading~~ that leads light emitted from ~~said~~ the light source into an object to be observed; and

a reference optical path ~~for leading~~ that leads the light from ~~said~~ the light source to a reference surface; ~~and~~

an image pick-up member ~~for photographing~~ that picks up an interference image of ~~said~~ the object formed by ~~said~~ the interference optical system; and

a computer,

wherein ~~said optical apparatus is operated through a process for calculating~~ the computer calculates out a phase distribution from ~~a photographed~~ an interference image picked up by the image pick-up member and ~~a calculation process for detecting~~ detects a phase distribution on ~~said~~ a surface of the object by using the following equation:

$$\Phi(x,y) = \varphi_I(x,y) / \{1 - [\varphi_I(x,y)]^2 / 2\}$$

where $\varphi_I(x,y)$ is ~~a~~ the phase distribution calculated out from ~~said~~ the photographed interference image and $\Phi(x,y)$ is a phase distribution on ~~said~~ the surface of the object.

13. (New) A method for detecting physical amount of object, comprising:

preparing a microscope optical system, the microscope optical system having a light source, an illumination optical system that leads light emitted from the light source to an object to be observed, and an imaging optical system that forms an image of the object;

preparing at least one polarizing member for separating the light from the light source into two polarized components;

preparing an adjusting member for changing an amount of retardation between the two polarized components;

preparing an image pick-up member for picking up a differential interference contrast image of the object;

picking up two differential interference contrast images of the object that have retardations equal in amount and different in sign with the image pick-up member; and

making a computer to conduct a procedure, the procedure comprising the processes of:

performing a difference operation and a sum operation for each pair of corresponding pixels in pictures of the two differential interference contrast images, to obtain difference image information and sum image information; and

detecting an amount of phase $\Phi(x,y)$ on a surface of the object corresponding to image information for each pixel by using one of the following equations:

$$\Phi(x,y) = k \cdot \{(1-\cos\theta) \cdot d(x,y) / \alpha\} / \{\sin\theta \cdot [1 - \{d(x,y)/\alpha\}^2/2]\}$$

$$\Phi(x,y) = k \cdot \tan^{-1}[\{(1-\cos\theta) \cdot d(x,y)/\alpha\}/\{\sin\theta \cdot [1 - \{d(x,y)/\alpha\}^2/2]\}]$$

where θ is the amount of retardation, $D(x,y)$ is the difference image information, $S(x,y)$ is the sum image information, $\Phi(x,y)$ is the amount of phase on the surface of the object corresponding to image information for each pixel, $d(x,y)$ is image information that is yielded by deconvolution of the difference image information $D(x,y)$ using an optical transfer function of the microscope optical system, α is an average value of the sum image information $S(x,y)$, $k = \lambda/4\pi$, and λ is a wavelength.

14. (New) A method for detecting physical amount of object, comprising:

preparing an interference optical system, the interference optical system having a light source, an illumination optical path that leads light emitted from the light source to an object to be observed, and a reference optical path that leads the light from the light source to a reference surface;

preparing an image pick-up member for picking up an interference image of the object formed by the interference optical system; and

detecting, with a computer, an amount of phase $\Phi(x,y)$ on a surface of the object corresponding to image information for each pixel using one of the following equations:

$$\Phi\,(x,y) = k \cdot \{h\,(x,y)\,/\,J_m\,(x,y)\,\}\,/\,\{[1 - \{h\,(x,y)\,/\,J_m\,(x,y)\,\}^2\,/\,2]\}$$

$$\Phi\,(x,y) = k \cdot \tan^{-1}[k \cdot \{h\,(x,y)\,/\,J_m\,(x,y)\,\}\,/\,\{[1 - \{h\,(x,y)\,/\,J_m\,(x,y)\,\}^2\,/\,2]\}]$$

where $H(x,y)$ is image information that is a phase distribution of the object <u>as</u> picturized, $h(x,y)$ is image information that is yielded by deconvolution of the image information $H(x,y)$ using an optical transfer function of the interference optical system, $J(x,y)$ is image information that is an intensity distribution as picturized, $J_m(x,y)$ is image information in which maxima of the

image information $J(x,y)$ are enveloped, $\Phi(x,y)$ is the amount of phase on the surface of the object, $k = \lambda/4\pi$, and λ is a wavelength.

15. (New) A method for detecting physical amount of object, comprising:

preparing a microscope optical system, the microscope optical system having a light source, an illumination optical system that leads light emitted from the light source to an object to be observed, an imaging optical system that forms an image of the object, and at least one polarizing member that separates the light from the light source into two polarized components;

preparing an adjusting member for changing an amount of retardation between the two polarized components;

preparing an image pick-up member for picking up a differential interference contrast image of the object;

picking up two differential interference contrast images of the object that have retardations equal in amount and different in sign with the image pick-up member; and

making a computer to conduct a procedure, the procedure comprising the processes of:

performing a difference operation and a sum operation for each pair of corresponding pixels in pictures of the two differential interference contrast images, to obtain difference image information and sum image information; and

detecting an amount of phase $\Phi(x,y)$ on a surface of the object corresponding to image information for each pixel by using one of the following equations:

$$\Phi(x,y) = k \cdot \{(1 - \cos\theta) \cdot d(x,y) / \beta(x,y)\} / \{\sin\theta \cdot [1 - \{d(x,y) / \beta(x,y)\}^2 / 2]\}$$

$$\Phi(x,y) = k \cdot \tan^{-1}[\{(1-\cos\theta)\cdot d(x,y)/\beta(x,y)\} / \{\sin\theta \cdot [1 - \{d(x,y)/\beta(x,y)\}^2/2]\}]$$

where θ is the amount of retardation between the two polarized components, $D(x,y)$ is the difference image information, $S(x,y)$ is the sum image information, $\Phi(x,y)$ is the amount of phase on the surface of the object corresponding to image information for each pixel, $d(x,y)$ is image information that is yielded by deconvolution of the difference image information $D(x,y)$ using an optical transfer function of the microscope optical system, $\beta(x,y)$ is image information in which maxima of image information $S(x,y)$ are enveloped, $k = \lambda/4\pi$, and λ is a wavelength.

16. (New) A method for detecting physical amount of object, comprising:

preparing a microscope optical system, the microscope optical system having a light source, an illumination optical system that leads light emitted from the light source to an object to be observed, an imaging optical system that forms an image of the object, and at least one polarizing member that separates the light from the light source into two polarized components;

preparing an adjusting member for changing an amount of retardation between the two polarized components;

preparing an image pick-up member for picking up a differential interference contrast image of the object;

picking up two differential interference contrast images of the object that have retardations equal in amount and different in sign with the image pick-up member; and

making a computer to conduct a procedure, the procedure comprising the processes of:

performing a difference operation and a sum operation for each pair of corresponding pixels in pictures of the two differential interference contrast images, to obtain difference image information and sum image information; and

detecting an amount of phase $\Phi\ (x,y)$ on a surface of the object corresponding to image information for each pixel by using one of the following equations:

$$\Phi\ (x,y) = k \cdot \{(1-\cos\theta) \cdot d\ (x,y)\ \} \ /\ \{\sin\theta \cdot \Gamma\ (x,y)\ \}$$

$$\Phi\ (x,y) = k \cdot \tan^{-1} [k \cdot \{(1-\cos\theta) \cdot d\ (\mathrm{x,y})\} \ /\ \{\sin\theta \cdot \Gamma\ (x,y)\ \}]$$

where θ is the amount of retardation between the two polarized components as detected, $D(x,y)$ is the difference image information, $S(x,y)$ is the sum image information, $\Phi(\mathrm{x,y})$ is the amount of phase on the surface of the object corresponding to image information for each pixel, $d(x,y)$ is image information that is yielded by deconvolution of the difference image information $D(x,y)$ using an optical transfer function of the microscope optical system, $\Gamma(x,y)$ is image information that is composed of information of a low-frequency component extracted from the sum image information $S(x,y)$, $k = \lambda/4\pi$, and λ is a wavelength.

17. (New) A method for detecting physical amount of object, comprising:

preparing an interference optical system, the interference optical system having a light source, an illumination optical path that leads light emitted from the light source to an object to be observed, and a reference optical path that leads the light from the light source to a reference surface;

preparing an image pick-up member for picking up an interference image of the object formed by the interference optical system; and

detecting, with a computer, an amount of phase $\Phi(x,y)$ on a surface of the object corresponding to image information for each pixel using one of the following equations:

$$\Phi(x,y) = k \cdot \{h(x,y) / J_c\} / \{[1 - \{h(x,y) / J_c\}^2 / 2]\}$$

$$\Phi(x,y) = k \cdot \tan^{-1}[k \cdot \{h(x,y) / J_c\} / \{[1 - \{h(x,y) / J_c\}^2 / 2]\}]$$

where $H(x,y)$ is image information that is a phase distribution of the object as picturized by the interference optical system, $h(x,y)$ is image information that is yielded by deconvolution of the image information $H(x,y)$ using an optical transfer function of the interference optical system, $J(x,y)$ is image information that is an intensity distribution as picturized, J_c is an average value of maxima of the image information $J(x,y)$, $\Phi(x,y)$ is the amount of phase on the surface of the object, $k = \lambda/4\pi$, and λ is a wavelength.

18. (New) A method for detecting physical amount of object, comprising:

preparing an interference optical system, the interference optical system having a light source, an illumination optical path that leads light emitted from the light source to an object to be observed, and a reference optical path that leads the light from the light source to a reference surface;

preparing an image pick-up member for picking up an interference image of the object formed by the interference optical system; and

detecting, with a computer, an amount of phase $\Phi(x,y)$ on a surface of the object corresponding to image information for each pixel using one of the following equations:

$$\Phi\,(x,y) = k \cdot \{h\,(x,y) \,/\, J_a(x,y)\,\} \,/\, \{\,[1 - \{h\,(x,y) \,/\, J_a(x,y)\,\}^2 / 2]\}$$

$$\Phi\,(\mathrm{x,y}) = k \cdot \tan^{-1}[k \cdot \{h\,(x,y) \,/\, J_a(x,y)\,\} \,/\, \{[1 - \{h\,(x,y) \,/\, J_a(x,y)\,\}^2 / 2]\}]$$

where $H(x,y)$ is image information that is a phase distribution of the object as picturized by the interference optical system, $h(x,y)$ is image information that is yielded by deconvolution of the image information $H(x,y)$ using an optical transfer function of the interference optical system, $J(x,y)$ is image information that is an intensity distribution as picturized, $J_a(x,y)$ is an average value of the image information J(x, y) as calculated for a predetermined region therein, $\Phi(x,y)$ is the amount of phase on the surface of the object, $k = \lambda/4\pi$, and λ is a wavelength.

19. (New) A method for detecting physical amount of object, comprising:

preparing an interference optical system, the interference optical system having a light source, an illumination optical path that leads light emitted from the light source to an object to be observed, and a reference optical path that leads the light from the light source to a reference surface;

preparing an image pick-up member for picking up an interference image of the object formed by the interference optical system; and

detecting, with a computer, an amount of phase $\Phi(x,y)$ on a surface of the object corresponding to image information for each pixel using one of the following equations:

$$\Phi\,(x,y) = k \cdot \{h\,(x,y) \,/\, J_L(x,y)\,\} \,/\, \{[1 - \{h\,(x,y) \,/\, J_L(x,y)\,\}^2 / 2]\}$$

$$\Phi\,(x,y) = k \cdot \tan^{-1}[k \cdot \{h\,(x,y) \,/\, J_L(x,y)\,\} \,/\, \{[1 - \{h\,(x,y) \,/\, J_L(x,y\,)\}^2 / 2]\}]$$

where $H(x,y)$ is image information that is a phase distribution of the object as picturized by the interference optical system, $h(x,y)$ is image information that is yielded by deconvolution of the image information $H(x,y)$ using an optical transfer function of the interference optical system, $J(x,y)$ is image information that is an intensity distribution as picturized, $J_L(x,y)$ is image information that is composed of information of a low-frequency component extracted from the image information $J(x,y)$, $\Phi(x,y)$ is the amount of phase on the surface of the object, $k = \lambda/4\pi$, and λ is a wavelength.

20. (New) A method for detecting physical amount of object, comprising:

preparing a microscope optical system, the microscope optical system having a light source, an illumination optical system that leads light emitted from the light source to an object to be observed, an imaging optical system that forms an image of the object, and at least one polarizing member that separates the light from the light source into two polarized components;

preparing an adjusting member for changing an amount of retardation between the two polarized components;

preparing an image pick-up member for picking up a differential interference contrast image of the object;

picking up two differential interference contrast images of the object that have retardations equal in amount and different in sign with the image pick-up member; and

making a computer to conduct a procedure, the procedure comprising the processes of:

performing a difference operation and a sum operation for each pair of corresponding pixels in pictures of the two differential interference contrast images, to obtain difference image information and sum image information; and

detecting an a phase distribution $\Phi(x,y)$ on a surface of the object by using the following equation:

$$\Phi\,(x,y) = \varphi(x,y) / \{1 - [\varphi(x,y)]^2 / 2\}$$

where $\varphi(x,y)$ is a phase distribution that is calculated from the difference image information and the sum image information and $\Phi(x,y)$ is the phase distribution on the object.

21 (New). A method for detecting physical amount of object, comprising:

preparing a microscope optical system, the microscope optical system having a light source, an illumination optical system that leads light emitted from the light source to an object to be observed, an imaging optical system that forms an image of the object, and at least one polarizing member that separates the light from the light source into two polarized components;

preparing an adjusting member for changing an amount of retardation between the two polarized components;

a step of preparing an image pick-up member for picking up a differential interference contrast image of the object;

picking up two differential interference contrast images of the object that have retardations equal in amount and different in sign with the image pick-up member; and

making a computer to conduct a procedure, the procedure comprising the processes of:

performing a difference operation and a sum operation for each pair of corresponding pixels in pictures of the two differential interference contrast images, to obtain difference image information and sum image information;

processing the difference image information with a deconvolution operation using an optical transfer function of the imaging optical system; and

calculating out a phase distribution from the difference image information that has undergone the deconvolution operation and the sum image information, to detect a phase distribution $\Phi(x,y)$ on a surface of the object using the following equation:

$$\Phi\ (\mathrm{x,y}) = \varphi_d(x,y) / \{1 - [\varphi_d(x,y)]^2 / 2\}$$

where $\varphi_d(\mathrm{x,y})$ is the phase distribution calculated out from the difference image information that has undergone the deconvolution operation and the sum image information and $\Phi\ (x,y)$ is the phase distribution on the surface of object.

22. (New) A method for detecting physical amount of object, comprising:

preparing a microscope optical system, the microscope optical system having a light source, an illumination optical system that leads light emitted from the light source to an object to be observed, an imaging optical system that forms an image of the object, and at least one polarizing member that separates the light from the light source into two polarized components;

preparing an adjusting member for changing an amount of retardation between the two polarized components;

preparing an image pick-up member for picking up a differential interference contrast image of the object;

picking up at least three differential interference contrast images that have different amounts of retardation with the image pick-up member; and

detecting, with a computer, a phase distribution $\Phi(x,y)$ on a surface of the object from the at least three differential interference contrast images by using the following equation:

$$\Phi\,(x,y) = \varphi_f(x,y) \,/\, \{1 - [\varphi_f(x,y)\,]^2 / 2\}$$

where $\varphi_f(x,y)$ is a phase distribution calculated out from the three differential interference contrast images and $\Phi(x,y)$ is the phase distribution on the surface of the object.

23. (New) A method for detecting physical amount of object, comprising:

preparing a microscope optical system, the microscope optical system having a light source, an illumination optical system that leads light emitted from the light source to an object to be observed, an imaging optical system that forms an image of the object, and at least one polarizing member that separates the light from the light source into two polarized components;

preparing an adjusting member for changing an amount of retardation between the two polarized components;

preparing an image pick-up member for picking up a differential interference contrast image of the object;

picking up at least three differential interference contrast images that have different amounts of retardation with the image pick-up member; and

making a computer to conduct a procedure, the procedure comprising the processes of:

calculating out a phase distribution from the at least three differential interference contrast images that have different amounts of retardation; and

processing the phase distribution with a deconvolution operation using an optical transfer function of the imaging optical system, to detect a phase distribution $\Phi(x,y)$ on a surface of the object using the following equation:

$$\Phi\,(x,y) = \varphi_{fd}(x,y) \,/\, \{1 - [\varphi_{fd}(x,y)\,]^2 / 2\}$$

where $\varphi_{fd}(x,y)$ is the phase distribution that has undergone the deconvolution operation and $\Phi(x,y)$ is the phase distribution on the object.

24. (New) A method for detecting physical amount of object, comprising:

preparing an interference optical system, the interference optical system having a light source, an illumination optical path that leads light emitted from the light source to an object to be observed, and a reference optical path that leads the light from the light source to a reference surface;

preparing an image pick-up member for picking up an interference image of the object formed by the interference optical system; and

making a computer to conduct a procedure, the procedure comprising the processes of:

calculating out a phase distribution from the interference image picked up by the image pick-up member; and

detecting a phase distribution on a surface of the object by using the following equation:

$$\Phi\ (x,y) = \varphi_i(x,y) / \{1 - [\varphi_i(x,y)\ ]^2 / 2\}$$

where $\varphi_I(x,y)$ is the phase distribution calculated out from the photographed interference image and $\Phi(x,y)$ is a phase distribution on the surface of the object.